

DOCUMENT RESUME

ED 212 473

SE 036 083

AUTHOR Vaidya, Sheila; And Others
TITLE Field-Dependence-Independence and Mathematics Problem-Solving.
PUB DATE Aug 81
NOTE 9p.; Paper presented at the Annual Meeting of the American Psychological Association (89th, Los Angeles, CA, August 24-28, 1981).
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Cognitive Development; *Cognitive Style; Educational Research; Elementary Education; *Elementary School Mathematics; *Grade 4; Individual Differences; Individualized Instruction; *Learning Theories; Mathematics Education; *Problem Solving
IDENTIFIERS *Field Dependence Independence; Heuristics; *Mathematics Education Research; Word Problems

ABSTRACT

Presented is a discussion of the nature of individual differences in the learning of mathematics, which leads to a review of field-dependent and field-independent cognitive styles. Field-dependence-independence is noted as an important variable in school learning and a study is cited that investigated the relationship between pupil success at solving mathematics word problems and cognitive style. The findings of that study formed a basis for the new investigation reviewed in this report. Twenty-eight fourth-grade subjects from a center-city Philadelphia school were selected in the new study, and two sets of word problems were presented to these subjects. One problem set was in standard form, the other consisted of word problems with adjunct questions. Results indicated that although there is some benefit to field-independent subjects when word problems are presented with adjunct questions, the gain among the field-dependent is greater. The findings are seen to justify the idea of training teachers in using strategies which are likely to help children structure the information within word problems. (MP)

 * Reproductions supplied by EDRS are the best that can be made *
 * from the original document. *

ED212473

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

- ☒ This document has been reproduced as received from the person or organization originating it.
- ☐ Minor changes have been made to improve reproduction quality.
- Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY

Sheila Vaidya

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."

FIELD-DEPENDENCE-INDEPENDENCE
AND MATHEMATICS PROBLEM-SOLVING

Sheila Vaidya Patricia Nasuti Lori Rockhill
Drexel University

Paper Presented at the Annual Meeting
Of the APA, Los Angeles, August 24-28, 1981

SE 036 083

Introduction

Despite some changes in the present educational philosophy and the development of new technology for teaching mathematics during recent years, there is little evidence that children are learning mathematics better than they did two decades ago. Some children continue to demonstrate high aptitude for the learning of mathematics, while other children continue to perform poorly. Those with a low aptitude for mathematics are often known to develop "math anxiety" and "school phobia." A report from the Educational Testing Service (1956) states the "mathematics has the dubious honor of being the least popular subject in the curriculum. Future teachers pass through the elementary schools learning to detest mathematics. They return to the elementary school to teach a new generation to detest it."

A better understanding of mathematics, with regard to both concepts and skills, is acknowledged to be important in this age of computer technology. Children who do not demonstrate a high aptitude for learning mathematics will eventually choose careers where such an aptitude is not required. However, while in school, it is necessary for all children to learn some mathematics. We also want children to develop positive self-images while in school through successful learning performance. From another aspect, we want to teach mathematics to children so that they might succeed in school and discover the joy in the process of successful mathematics problem-solving. Polya has said, "If a problem challenges one's curiosity, such experiences at a susceptible age may create a taste for mental work and leave their imprint on mind and character for a lifetime" (P. 1, 1973).

The art of teaching mathematics lies perhaps in helping children learn how to solve problems. For if a teacher can help a child construct suitable strategies for solving mathematical problems, than that teacher may well have awakened in the child a sense of the inner satisfaction that comes with meeting

an intellectual challenge. Moreover, a child's success at problem-solving may reasonably be expected to encourage the child's innate curiosity, for each success demonstrates the practicality of raising questions and formulating problems.

Unfortunately, a large number of teachers (Fey, 1979) still use the lecture method. Relative to problem-solving, this means that they simply tell their students how each presented problem is to be solved, thus reducing the problem-solving experience to a rote application of arithmetic. Under such circumstances, many children come to see mathematics as a somewhat mysterious collection of rules and formulas for getting answers and, quite reasonably are turned off. Of course, some few children are fascinated with mathematics regardless of the teaching method.

Consideration for individual differences in the learning of mathematics has resulted in the development of individualized programs of mathematics instruction. Based on Skinner's learning theory principles, many of these programs popular in the sixties, only addressed themselves to individual differences in the rate of learning, disregarding differences in the styles of learning.

The Personality Theory of Cognition makes us aware of the individual differences in the process of learning. For over thirty years, Witkin and his associates have been studying field-dependent and field-independent styles as contrasting ways people have of processing information. A field-independent cognitive style is characterized by an analytical approach to a situation, consisting of the ability to overcome the influence of an embedding context while inferring its salient features. In contrast, a field-dependent cognitive style is characterized by a global approach to a situation; it is determined by the prevailing context of a situation.

The field-dependent-independent cognitive styles have been found to be related to many perceptual and intellectual activities including the selection

of academic majors, the expression of vocational preferences, and performance in different subject areas (Witkin et al, 1977). A field-dependent person is known to be more competent than a field-independent person in situations that call for a social orientation, while a field-independent person is more adept at situations that require a high analytical ability.

Since its early development, the construct of field-independence-dependence has undergone some change. In their earlier writing (Witkin et al, 1959, 1962) field-dependence-independence is assessed using tests such as the Embedded Figures Test and the Rod and Frame Test as well as the Body Adjustment Test. All three tests assessed the ability to disembed from a complex context and were reported to be highly correlated to each other (Witkin et al, 1971). Recently, Witkin and Goodenough (1977) have stated that the Rod and Frame test assesses the subject's ability of cognitive restructuring. Linn's recent research (1980) confirms this evidence.

A problem in the assessment of field-dependence-independence is that it is not clearly distinct from general ability conceptualized by Cattell as "fluid intelligence"(see Cattell, 1963, 1971; Hoin and Cattell, 1967). Goodenough and Karp (1961) have found three Wechsler subtests; Block Design, Object Assembly and Picture Completion to comprise the field-independence factor. However, the three Wechsler tests represent fluid ability. More recently, Satterly (1976) has shown that field-dependence-independence is distinct from general ability factors. Since this issue is not completely resolved yet, it becomes necessary to incorporate IQ as a control variable while designing research on field-dependence-independence.

Although there is still a lack of clarity regarding the construct of field-dependence-independence and its assessment, much research exists to show that it is an important variable in school learning. Witkin, Moore,

Goodenough, and Cox (1975, 1977) have provided a review of the educational implications of this particular style. However, research dealing with how cognitive styles influence the learning of mathematics among children has been minimal.

While investigating the relationship between field-dependence-independence as assessed on the Children's Embedded Figures Test and mathematics achievement among second, third, and fourth-grade children, we have shown that a field-independent cognitive style was positively correlated with mathematics achievement at all grade levels, especially on subtests of concepts and problem-solving (Vaidya and Chansky, 1980). These findings suggest that the disembedding required in the Children's Embedded Figures Test is important in determining mathematics achievement.

Bien (1974) conducted a study showing that success at solving mathematics word problems among 143 fourth grade children differs according to cognitive style. Bien found that children who are field-independent, set up and correctly solve more word problems than do field-dependent children. But they do not differ in their ability to carry out arithmetic computations.

But when the word problems were presented in a new fashion using what Bien calls a cognitive-perceptual structure, there was no statistically significant difference in performance among field-dependent and field-independent subjects in solving word problems. Perceptual structure was provided by underlining certain key concepts in the word problem. Cognitive-Perceptual Structure was provided by underlining the key concepts as well as asking the subjects questions about the key concepts.

In the above instance, field-dependent subjects succeeded only when the problems were presented using the Perceptual-Cognitive Structure alone did not influence performance. Cognitive Structure alone was not explored.

Since field-dependent subjects need aid in disembedding relevant information, it may be reasonable to assume that perceptual-cognitive structure was more relevant than perceptual or cognitive structure alone. In this study, it was also found that after field-dependent subjects had solved a set of word problems in this manner, they were able to correctly solve the unstructured problems. This suggested a transfer effect of the strategy learned when a perceptual and cognitive structure was provided to solving problems where such a structure did not exist, thereby enabling field-dependent subjects to solve problems as they are normally presented.

Based on the above findings, the present study explored the implication of asking adjunct questions to subjects at the end of a word problem.

Sample: The sample consisted of 28 fourth-grade subjects (14 boys and 14 girls) from a center city Philadelphia school.

Procedure: Field-dependence-independence was assessed using the Children's Embedded Figures Test. Two sets of mathematics word problems were presented to the subjects. There were five problems in each set. One set consisted of word problems with adjunct questions, the second set of problems was in the standard form. A typical example of a standard problem and one with adjunct questions is as follows:

Standard Presentation:

Nine out of 15 boys from Room 1 are playing football with all 7 boys from Room 2. Of the 25 boys in Room 3, 15 are playing football, while the remaining are watching the football game on TV. How many boys in all are not playing football?

Problem with adjunct questions:

Nine out of 15 boys from Room 1 are playing football with all 7 boys from Room 2. Of the 25 boys in Room 3, 15 are playing football, while the remaining are watching the football game on TV. How many boys in all are not playing football?

Questions: 1. How many boys are there altogether?

- a. Room 1 _____
- b. Room 2 _____
- c. Room 3 _____

2. How many boys from Room 1 are not playing? _____
3. How many boys from Room 2 are not playing? _____
4. How many boys from Room 3 are not playing? _____

Results: Field independent subjects correctly solved a total of 33 problems in Set I (Standard Presentation); while they correctly solved 44 problems in Set II (Problem with adjunct questions). Field dependent subjects correctly solved a total of 21 problems in Set I (Standard Presentation); while they correctly solved 43 problems in Set II (Problems with adjunct questions.)

Discussion: The results demonstrate that although there is some benefit to field independent subjects when the word problems are presented with adjunct questions, the gain among the field-dependent is greater.

The findings of the study justify the idea of training teachers in the use of some of the strategies which are likely to help children structure the information within the word problem. Furthermore, it may be worthwhile to explore the strategies employed by field-dependent and field-independent children in solving mathematics word problems.

References

- Bien, E. C., The relationship of cognitive style and structure of arithmetic materials to performance in fourth grade arithmetic, (Doctoral Dissertation, University of Pennsylvania, 1974) Dissertation Abstracts International, 1974, 2040-2041.
- Cattell, R. D. Theory of fluid and crystallized intelligence: A critical experiment. Journal of Educational Psychology, 1963, 54, 1-22.
- Educational Testing Service Report (1956) quoted in Poly, G. How to Solve It. Princeton University Press, Princeton, New Jersey, 1973.
- Fey, J. T. Mathematics Teaching Today: Perspectives from three National Surveys for the elementary grades. In: What are the Needs in Precollege Science, Mathematics, and Social Science Education? Views from the Field. Publication of the National Sciences Foundation. Office of Program Integration. Directorate for Science Education. SE 80-9, 1979.
- Goodenough, D. R. and Karp, S. A. Field-dependence and intellectual functioning. Journal of Abnormal and Social Psychology, 1901, 63, 241-246.
- Horn, J. L. and Cattell, R. D. Age differences in fluid and crystallized intelligence. Aeta Psychologia, 1967, 26, 107-119
- Linn, M. C. The field dependence-independence construct: Some, one, or none. Paper presented at the American Educational Research Association Meeting, April, 1980, Boston, Mass.
- Polya, G. How to Solve It. Princeton University Press, Princeton, New Jersey, 1973.
- Satterly, D. J. Cognitive style, spatial ability and school achievement. Journal of Educational Psychology. 1976, 68, 36-42.
- Vaidya, S and Chansky, N. Cognitive Development and Cognitive Style as factors in Mathematics Achievement. Journal of Educational Psychology, 1980, 72, 326-330.
- Witkin, H. A. and Goodenough, D. R. Field dependence revisited (ETS RB 77-16) Princeton, NJ. Educational Testing Service, 1977.
- Witkin, H. A.; Moore, C. A. Goodenough, D. R.; and Cox, P. W. Field-dependent and field-independent cognitive styles and their educational implications. Research Bulletin 75-24. Princeton, NJ. Educational Testing Service, 1975.
- Witkin, H. A.; Ottman, P. K.; Rashkin, E; and Karp, S. A. A Manual for the Embedded Figures Test, Consulting Psychologists Press, 1971.